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Ionic Polymer-Metal Composite coated with Polyaniline Film by Electrodeposition: a promising IPMC/PANI junction for applications in robotics and bioengineering

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Ionic polymer-metal composite (IPMC) actuators are a class of electroactive polymer composites formed by an ion-exchange membrane coated with metal electrode layers at both sides, which have been considered as a promising candidate to be used in actuators, bioinspired artificial muscles and sensors because of their advantageous properties like large deformation in the presence of low applied voltage, low weight, flexibility, softness, low power consumption, rapid response and mechanical and chemical tolerance and stability. However, IPMC tends to form cracks and wrinkles that decrease electric conductivity of the electrode, cause significant water leakage and loss of electromechanical response principally on the surface. To overcome these disadvantages and optimize time and cost of manufacturing, as well as increase the reliability of the composite, an IPMC coated with polyaniline (PANI) eletrodeposited by the potentiostatic electrodeposition method was developed. Polyaniline was chosen as the conducting polymer due to its wide variation of conductivity, tunable redox behavior, nanostructured morphology and low cost. In this study, IPMC/PANI junction were prepared by impregnation and reduction technique using precursor salt to form a thin film of platinum, with reduced thickness, which provides the formation of a reasonable interfacial for area to polyaniline electrodeposition. The characterization of the IPMC/PANI junction was performed before and after dynamic operation by RAMAN and XRD spectroscopy, AFM, SEM-FEG and HRTEM microscopy and by electrochemical impedance spectroscopy. The developed IPMC/PANI junction exhibit remarkably stronger electromechanical properties and longer stable working time, which could be used as actuators for various applications at low cost. The electrochemical results showed that it is possible to obtain regular films of PANI on the IPMC surface by potentiostatic conditions, with electrical oxidation potential between 0.9 V and 1.1 V and electrodeposition times of 15 minutes. The electrodynamic performance of the IPMC/PANI junctions can be considered good, with typical strains and polarization electrical potential. But after electrodynamic tests, the surface of the IPMC/PANI junctions showed smaller and different defects than the IPMC membranes, a promising result if these junctions were applied to manufacture devices that require longer usage time.